

Reducing Error Rates Using IT and the Role of the Internet

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Goals

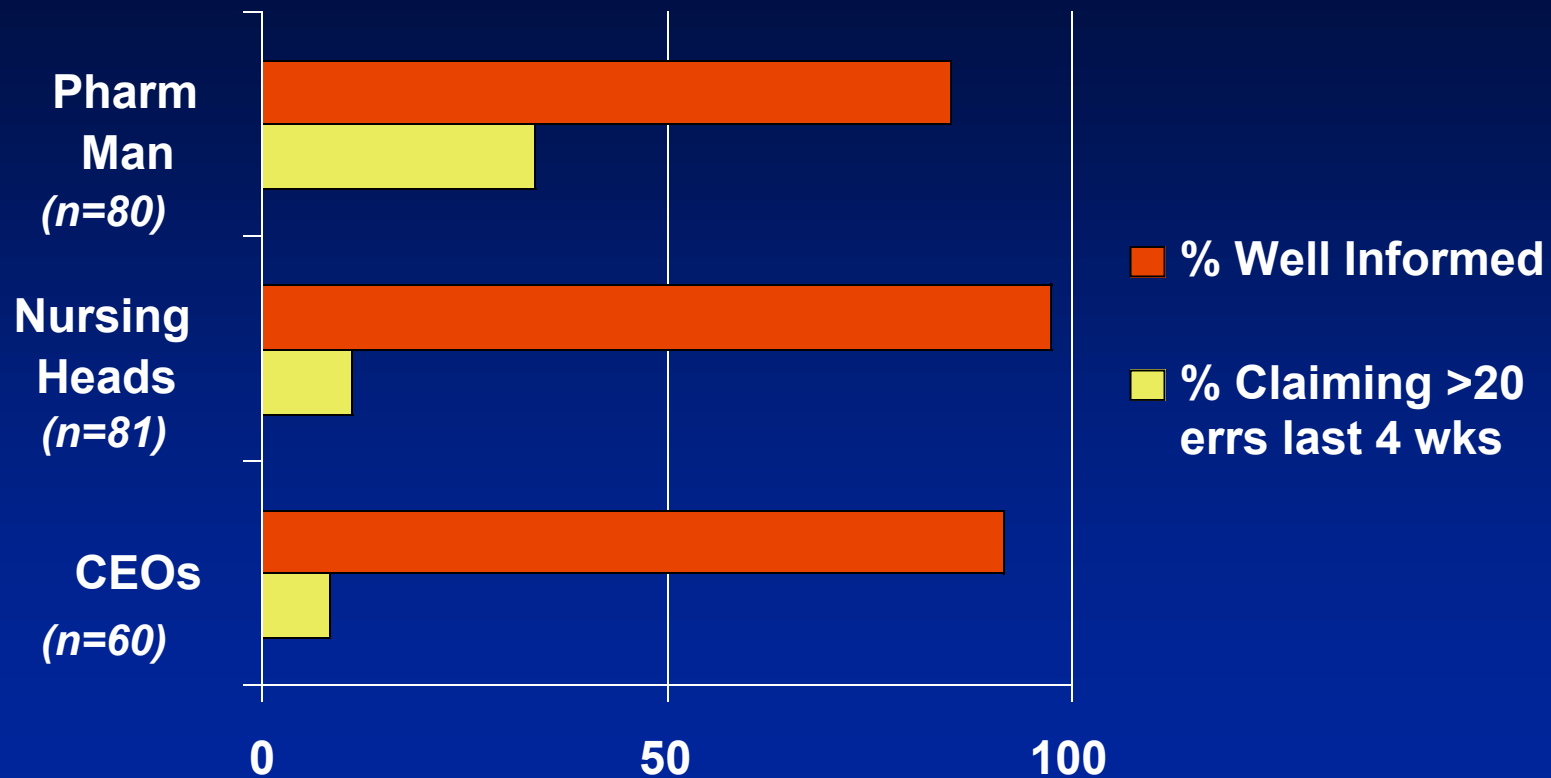
- **Iatrogenic injury background**
- **Theory relating to POE**
 - Implementing POE
- **Medication safety**
 - Epidemiology of ADEs and medication errors
 - Medication error prevention
 - Reducing drug costs
- **Overarching lessons learned**

The IOM Report

- **Report targets hospital errors: Mistakes killing thousands every year 11/30/99**
 - Medical errors kill 44,000-98,000 people per year
 - “More people die from medical errors each year than from suicides, highway accidents, breast cancer, or AIDS”
- **“These stunningly high rates of medical errors - resulting in deaths, permanent disability, and unnecessary suffering - are simply unacceptable in a system that promises to first ‘do no harm.’”**

William Richardson

Administration's Awareness of Medication Errors



Source: Brusking Goldring Res, 1999
sponsored by BD.id

Reengineering Medicine: The Role of IS

- **Could be changed by providing external aids**
 - Linking medical knowledge and patient-specific data
 - Identifying options
- **Without such tools, experts**
 - Overlook available knowledge
 - Don't sufficiently account for uniqueness
- **Modern information tools could**
 - Improve information access to experts
 - Allow patients to more effectively participate in decision-making

Weed LL, Weed L, *Federation Bulletin*, 1994

Principles of Changing Physician Behavior

- Changing behavior is hard
- Education and feedback are most likely to succeed
- Feedback is most likely to influence decision-making if it is delivered as closely as possible to the time of the decision;
 - Ideal to deliver *at the time the decision is being made*

Advantages of Computerized Guidelines

- Facilitate memory, always findable
- Immediately generalizable to all patients, providers
- Possible to point providers to them
- Facilitates central control
- Allows measurement of outcomes
 - Whether people use
 - If not, why
 - Patient outcomes
- Easy to get feedback to developers, allows iterative refinement

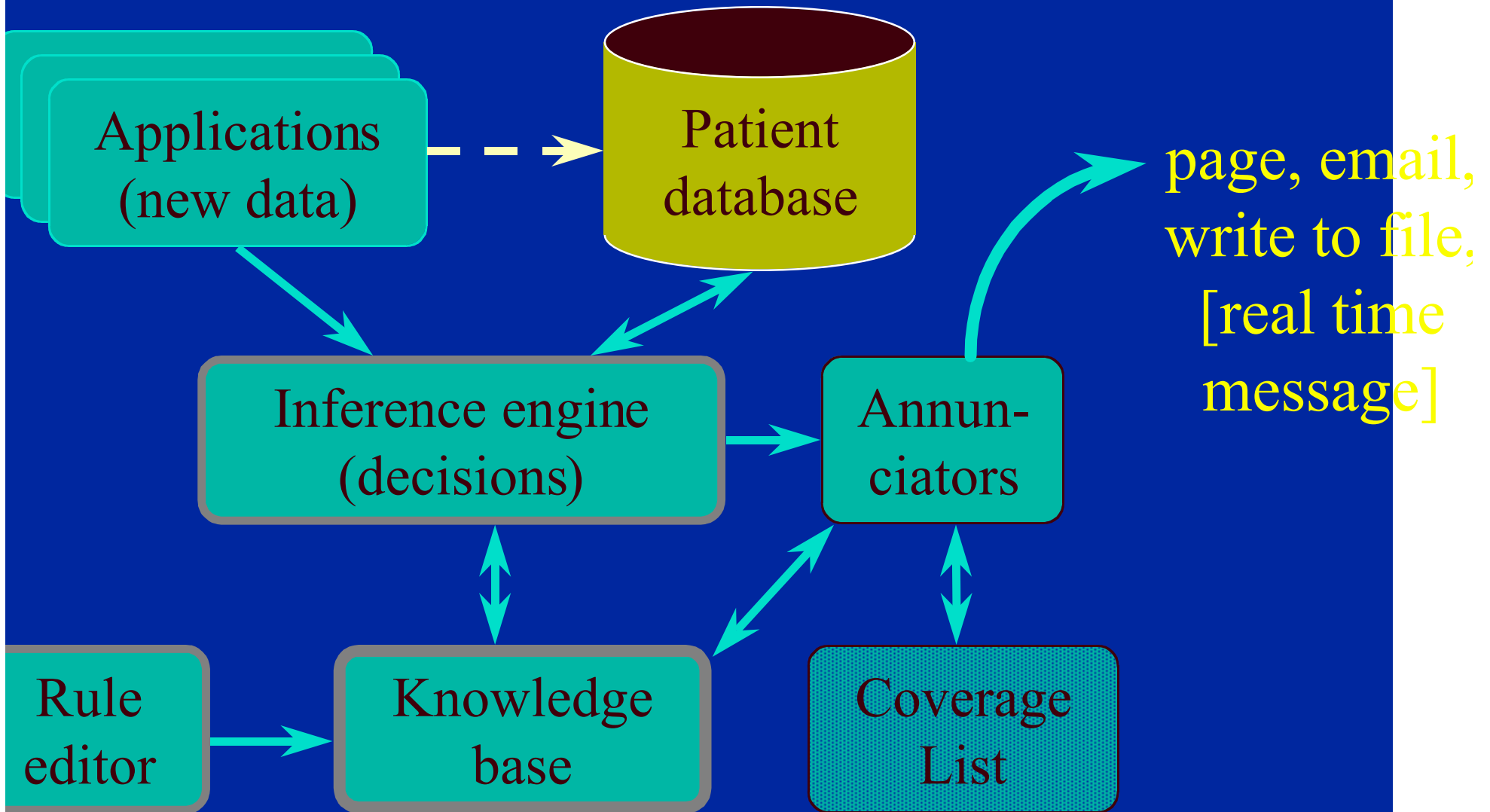
Why Use the Internet?

- **Provides a single common platform**
 - Standards have been a bugaboo
- **Wide dispersion, remote sites easy**
- **Thin client is attractive**
 - Most developers now building new applications using Web front end

Development and Implementation of POE at BWH: Key Success Factors

- **Physician involvement and leadership**
- **Decision to automate existing systems as is**
- **Constant focus on speed**
- **Strong support from hospital administration**
- **Willingness to be flexible, modify system**

Event monitor architecture



Physician Coverage List

- **Functions**

- Identifies first and second-call physicians
- Manages physician rotation
- Handles evening coverage and signing out

- **Facilitates delivery of computer-generated messages**

- Computer-page interface allows automated paging

Do We Have the Systems We Need in Place? Results of a National Pharmacy Computer System Field Test of Unsafe Orders

	<i>Unsafe order not detected</i>
<i>1. cephradine oral suspension IV</i>	<i>61%</i>
<i>2. vincristine 3 mg IV x 1 dose (2-year-old)</i>	<i>62%</i>
<i>3. colchicine 10 mg IV for one dose (adult)</i>	<i>66%</i>
<i>4. cisplatin 204 mg IV x 1 dose (26 kg child)</i>	<i>63%</i>

Source: ISMP Medication Safety Alert! Feb 10, 1999

Medication Error Frequency and Potential for Harm

In 10,070 Orders

530 Medication Errors 1.4 per admission

35 Potential ADEs

5 Preventable ADEs

- 1 in 100 medication errors results in an ADE
- 7 in 100 represent potential ADEs

Bates et al, J Gen Int Med, 1995

ADE Prevention Study: Key Results

- **6.5 ADEs/100 admissions**
 - 28% preventable
 - 3 potential ADEs for every preventable ADE
 - 62% of errors at ordering and transcription stages

JAMA 1995;274:29-43

Costs of ADEs

- **ADEs are expensive**
 - \$2461 per ADE, \$4555 per preventable ADE
 - Annual BWH costs:
 - \$5.6 million for all ADEs
 - \$2.8 million for preventable ADEs
- **These figures exclude costs of:**
 - Injuries to patients
 - Malpractice costs
 - Costs of admissions due to ADEs
- **Figures justify investment in prevention efforts**

JAMA 1997;277:307-311

Implications of Systems Analysis for Error Prevention

- Improved information access
 - Computer can provide information at time needed
- Reduced reliance on memory
 - Choices from menus
- Standardization
- Error-proofing
- Training

Leape et al, JAMA, 1995

Improving the Quality of Drug Ordering with Order Entry

- **Streamline, structure process**
 - Doses from menus
 - Decreased transcription
 - Complete orders required
- **Give information at the time needed**
 - Show relevant laboratories
 - Guidelines
 - Guided dose algorithms
- **Perform checks in background**
 - Drug-allergy
 - Drug-drug
 - Drug-laboratory
 - Dose ceiling
 - Drug-patient characteristic

Allergy to Medication

BICS

ViewOrders PtLookup Feedback Help Goodbye

TEST,TEST 34F 00000000 Adm: 11/01/91 Room:

DRUG WARNING(S) FOUND

Current Order:
DICLOX PO

Warnings:

POSSIBLE ALLERGY
POSSIBLE ALLERGY

Message:

Pt. has a POSSIBLE allergy to PENICILLINS.
(Documented allergy to CEPHALOSPORINS --> HIVES.)

(<*)C Cancel order Ok
< >K Keep (override) order

Use up & down arrow keys to read warning messages.

Drug-Drug Interaction Checking

```
Mumps
View PtLookup
Patient: C[ ] R[ ] 29F 07535[ ]
Time: 02/03/95 04:52 PM Alert#82343
Alert: PATIENT ON FLUOXETINE & MAO INHIBITORS -- POTENTIALLY FATAL; DISCONTI
Reason: Patient is currently on FLUOXETINE HCL.
Patient is currently on PROCARBAZINE.
Relevant medications: Alert Details
Act- A Exit directly to Order Entry
ions:
Covering M.D.: Bp# Page M.D.
done <done, Go to OE> comments Logic
Press ALT-O or ALT-G to exit and acknowledge alert.
```

Chemotherapy Order: Patient Characteristics

BICS

ViewOrders PtLookup Feedback Help Goodbye

TEST,TEST 34F 00000000 Adm: 11/01/91 Room:

--- **Chemotherapy Order Profile** ---

Currently ordering: ADRIAMYCIN <DOXORUBICIN> IU

X Primary Diagnosis: [meitis]

I Indication for Chemotherapy: [same]
<if diff. from primary dx>

P Research Protocol Name & No.: [7655676]

H Heig
C Heig
L Weig
W Weig

Calc
Patient's height is 66 inches. (167.6 cm)
Patient's weight is 178.2 pounds. (81.0 kg)
Patient's BSA is 1.91
Is this correct?

B Dosi
R Rout

< Ok >

Type the letter of the field you wish to change.
Press Enter or Alt-0 to accept. Esc to cancel.

High Chemotherapy Dose Warning

The screenshot shows a terminal window titled "BICS" with a menu bar containing "ViewOrders", "PtLookup", "Feedback", "Help", and "Goodbye". Below the menu bar, patient information is displayed: "TEST,TEST 34F 00000000" and "Adm: 11/01/91 Room:". The main window is titled "Chemotherapy Medication Parameters" and shows the medication "ADRIAMYCIN (DOXORUBICIN) IUB". A red-bordered warning box is overlaid on the screen, containing the following text:

```
---  
WARNING -- HIGH CHEMOTHERAPY DOSE  
  
39mg/m2 Q4H exceeds the daily maximum dose limit of  
60mg/m2 for DOXORUBICIN  
Are you sure about this order?  
  
<No, return to template to change dose. >  
<Yes, Continue order with current dose. >
```

To the right of the warning box, the text "ended by Pharmacy" is visible, along with some vertical alignment markers ("]", "]", "]").

High Chemotherapy Dose: Requires Attending Physician's Approval

BICS

ViewOrders PtLookup Feedback Help Goodbye
TEST,TEST 34F 00000000 Adm: 11/01/91 Room:

--- Chemotherapy Medication Parameters

Med

--- Specify Attending Physician

Physician name
[David Bates, M.D.]

<

<Ca

No entries found

Enter the name of the physician who originated
this order. Last,First or clinical ID

Type the letter of the field you wish to change.
Press Enter or Alt-0 to accept. Esc to cancel.

gh chemotherapy doses.
oved.
e orders
r cancel orders
ancel

Results of Two Studies on Medication Error Prevention

- **First study uses non-missed dose medication errors as main outcome**

- Design--interrupted time series over 5 years
- Intervention--POE at several stages of development
- Units studied--three medical units

Bates, *JAM IA* 1999

- **Second study uses serious medication errors as main outcome**

- Design--controlled trial, using both contemporaneous and time series comparisons, over 15-month period
- Intervention--POE at one stage, and a team intervention
- Units studied--6-8 units

Bates, *JAMA* 1998;280:1311-6

Systems Characteristics By Period

Baseline

- Orders written on paper
- No automated decision support

System Characteristics By Period

Period 1

- **Complete orders required**
- **Medication name, dose and frequency selection from lists**
- **Relevant laboratories displayed**
- **Decreased transcription**
- **Rudimentary drug-allergy checking**
- **Redundant medication checking**
- **Rudimentary drug-drug interaction checking**
- **Notification for several drug-laboratory problems**
- **Many orders entered using preapproved order sets**

Systems Characteristics By Period

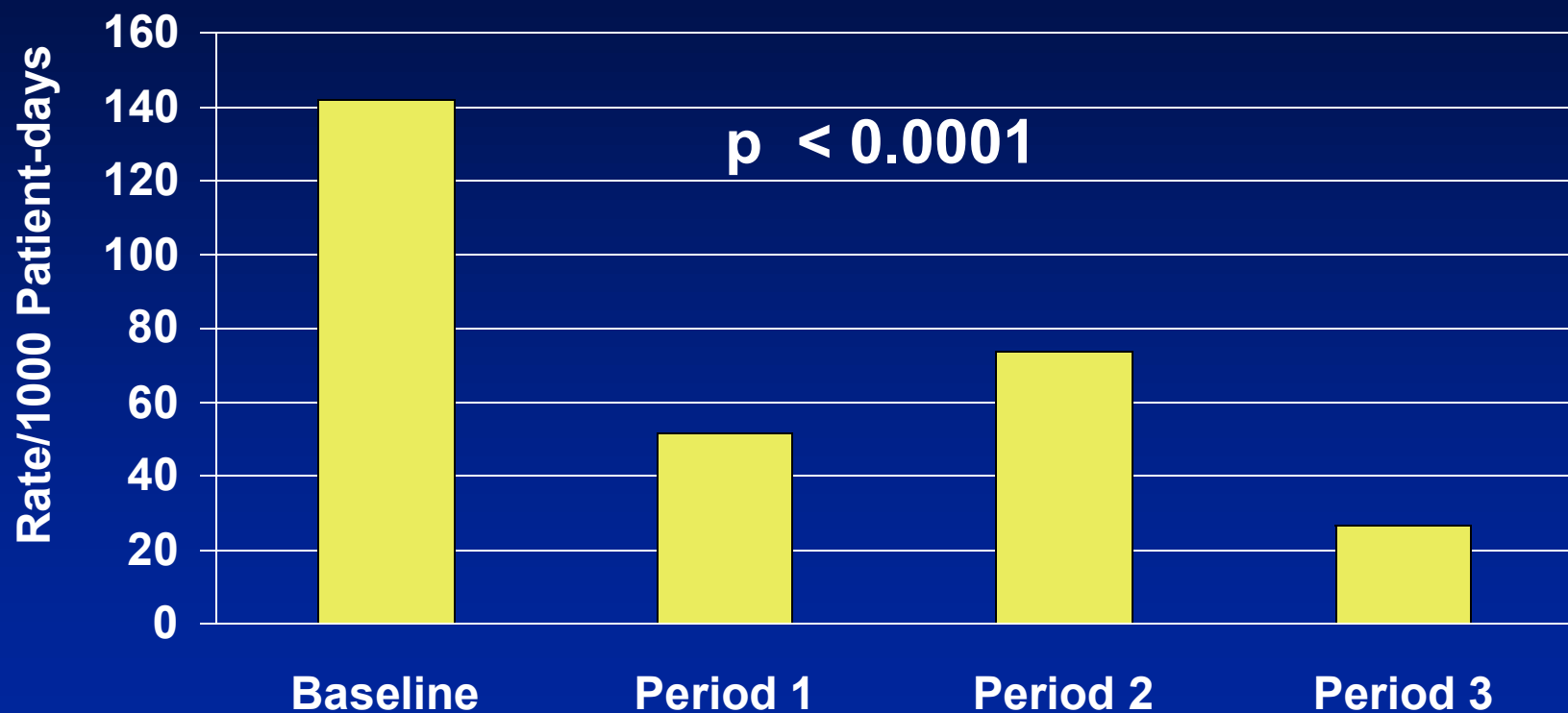
Period 2

- Improved drug allergy checking

Period 3

- Improved potassium ordering
- Improved drug-drug interaction checking

Non-Missing Dose Medication Error Rate



Study Conclusions

- **Non-missed dose medication error rate fell 81%**
 - Serious medication error rate fell 86% from beginning of study to end
- **Three quarters of reduction in medication error rate was achieved with a relatively simple system**

Impact of Computerized POE and a Team Intervention on Serious Medication Errors

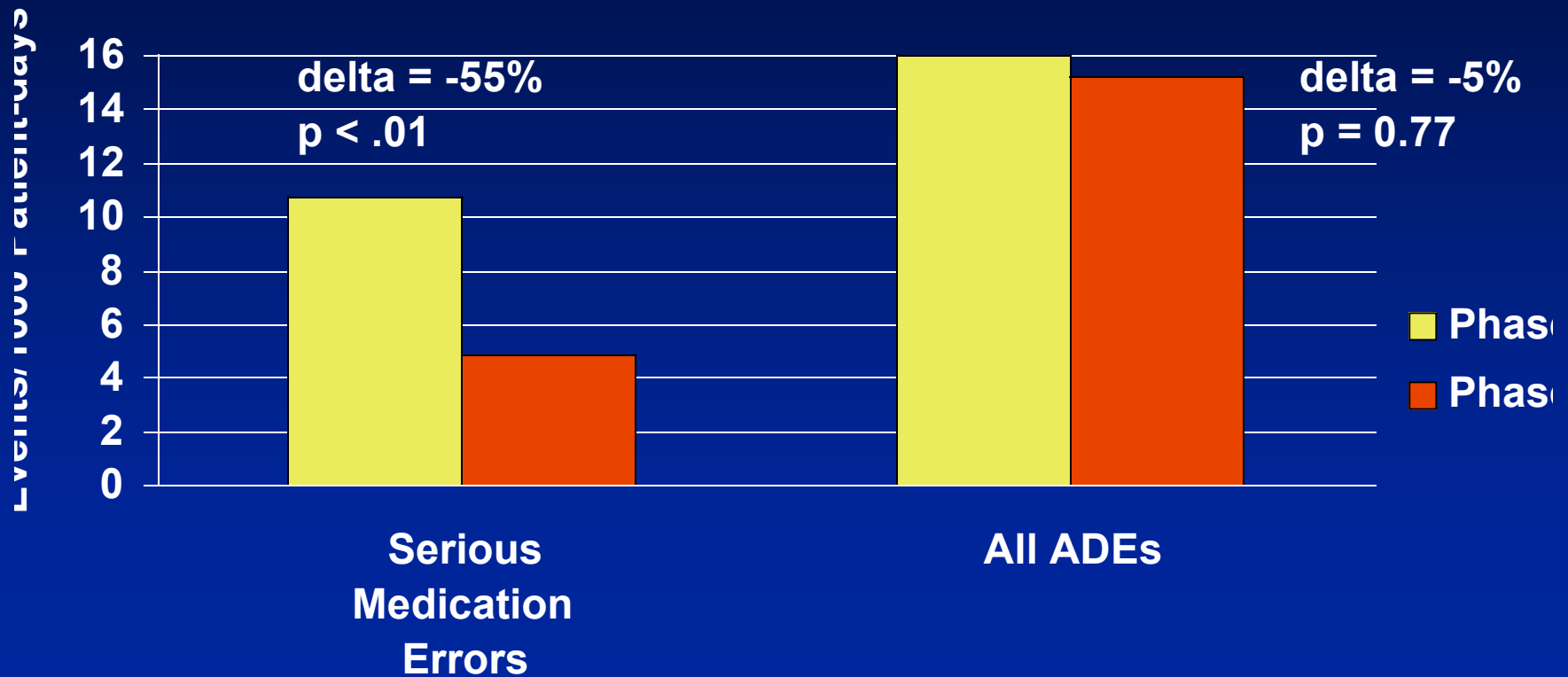
- **POE Intervention**

- All orders complete
- Transcription minimized
- Early checking including drug-allergy, drug-drug

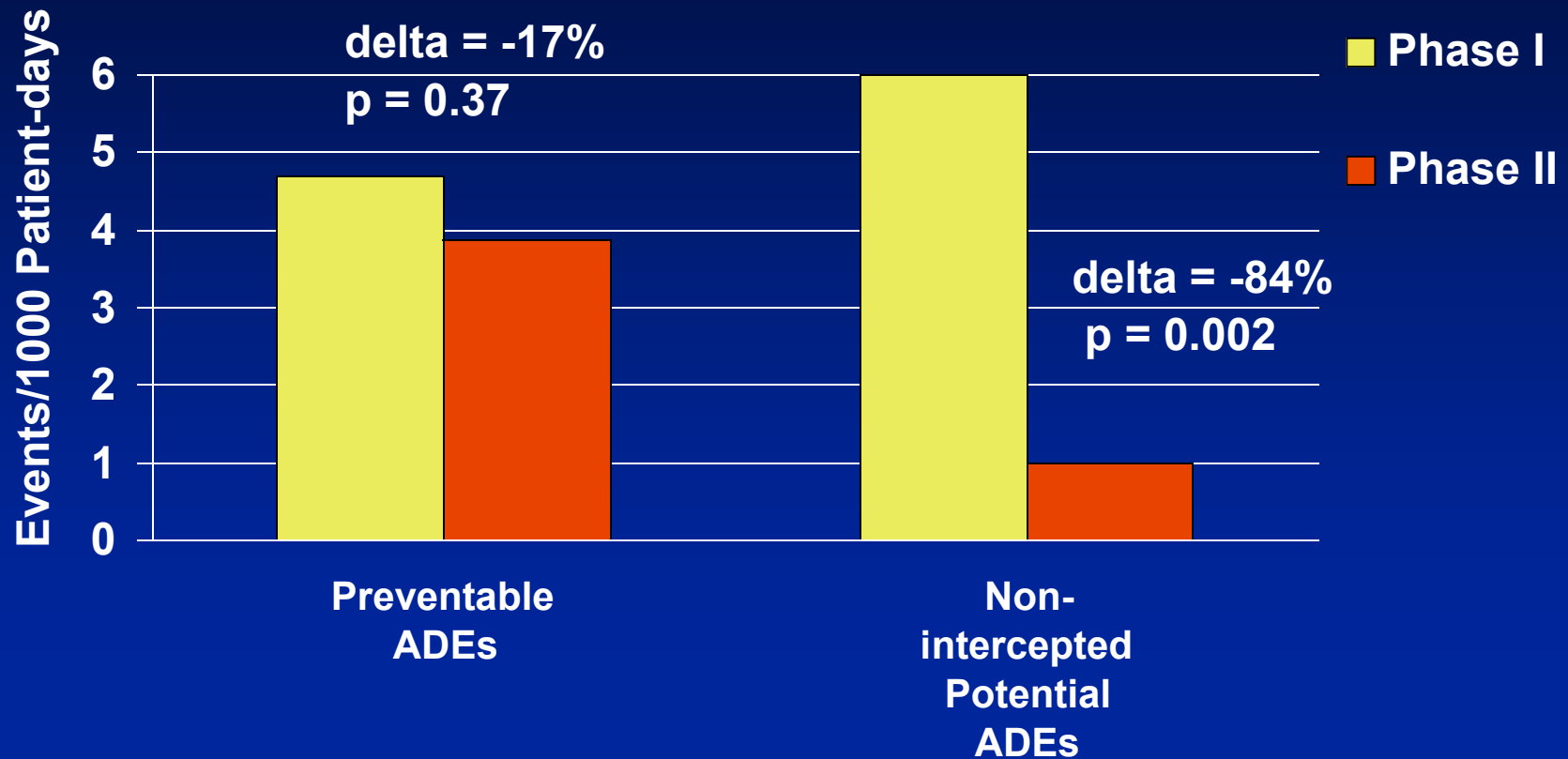
- **Team Intervention**

- Changing role of pharmacist
- Computerized drip rate calculation program
- Standardized labeling of bags, tubes and pumps
- Implementing pharmacy communication log to facilitate communication between nursing and pharmacy

Comparison of Serious Medication Error and ADE Rates



Paired Comparison of Preventable ADEs and Non-intercepted Potential ADEs



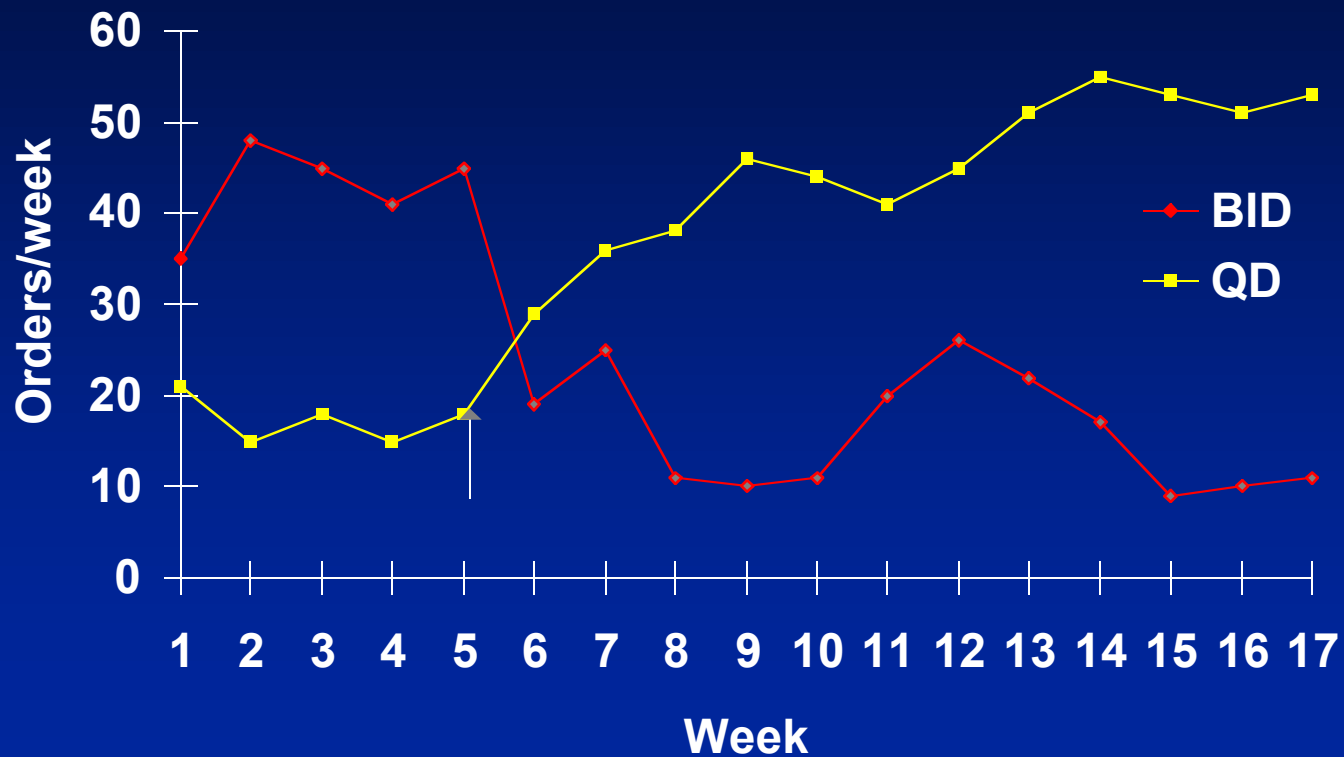
Study Conclusions

- Serious medication error rate fell by over half
- Potential ADE rate fell more than preventable ADE rate
- Additional evaluation of interventions like team interventions should be done
- Further reductions possible with additional improvements
 - System evaluated was missing many features

Reducing Drug Costs and Improving Use with Order Entry

- **Types of useful suggestions**
 - Drug interchange
 - Lower dose
 - Different route (IV-PO switches)
 - Guidelines for use

Effect of Changing Default Dosing Frequency for Ceftriaxone



Guideline for Expensive Agent

Mumps

ViewOrders PtLookup Feedback Help Goodbye

TEST,TEST 34F 00000000 Adm: 11/01/91 Room:

P&T NOTICE - HUMAN GROWTH HORMONE

The use of human growth hormone (\$175 per dose) has been approved only for the patient who is receiving adequate nutrition, has adequate arterial oxygenation (SaO₂>90%), and has:

- A major burns, documented impaired healing over 10 days, age>60; OR
- B major burns, documented impaired healing over 10 days, and debilitating underlying condition (e.g., renal failure); OR
- C burns >80% total body surface, who requires rapid healing of donor sites to improve survival; OR
- D large traumatic wound(s), documented impaired healing over 10 days.

Please indicate the applicable reason.

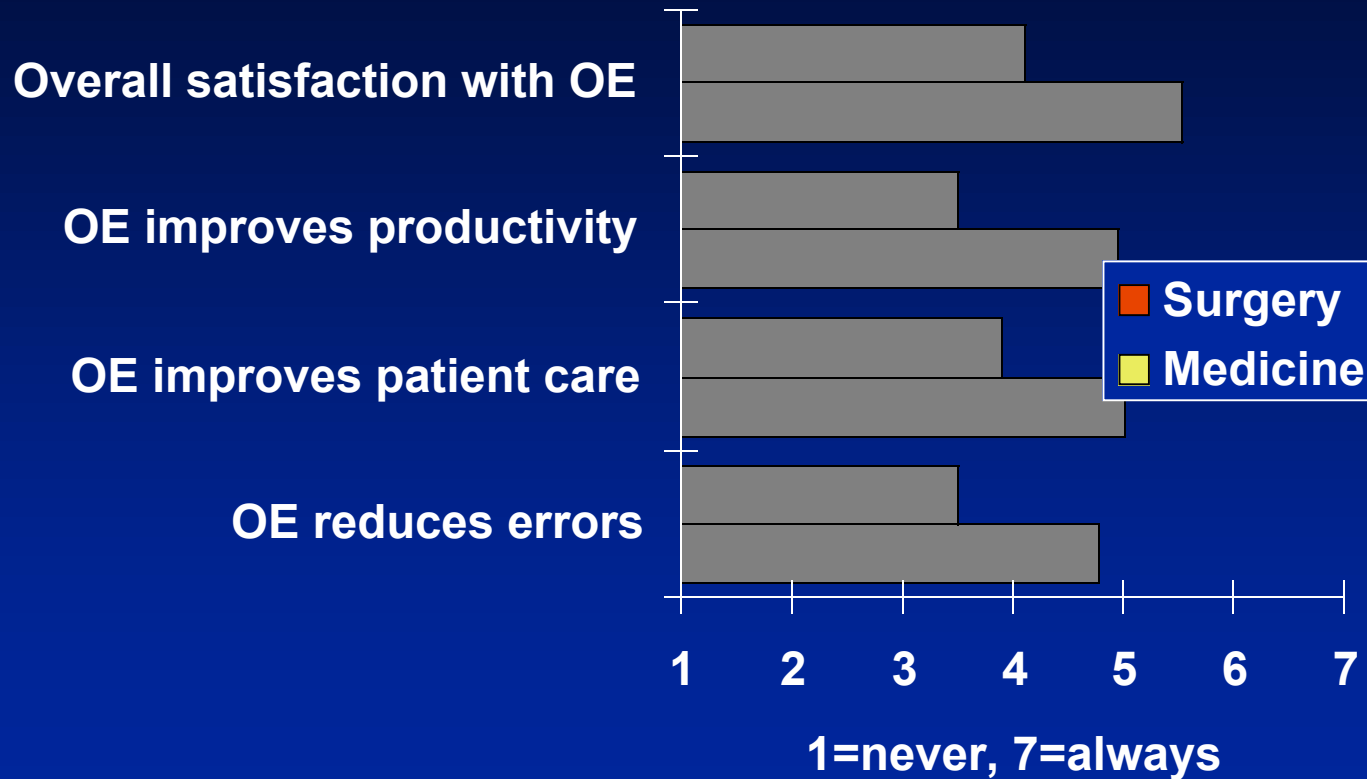
Requests concerning exceptions to these guidelines must be made in writing by the attending physician to the chairman of the Pharmacy and Therapeutics Committee, Dr. Jamie Maguire.

CoNtinue Current Order **Cancel Order**

Impact of Computer OE on Physician Time

- **Order writing took twice as long on computer**
 - Medical HOs 44 min/day, recovered half
 - Surgical HOs 73 min/day, no recovery
- **Daily and one-time orders accounted for most of change, increasing 3-fold**
- **Sets of orders took half the time they did before order entry**
- **Interventions**
 - Introduction of “Write 1”
 - Reorganization of screens to facilitate access to OE

HO Satisfaction with OE



Lee, *JAM IA*, 1996

Rough Cost-Benefit for POE

- **Costs:**

- Development \$1,000,000
- Hardware \$400,000
- Maintenance \$500,000/year

- **Benefits:**

- Overall \$5-10 million/year charges
- Main savings relate to efficiencies re drugs, ADE prevention, and tests
- Many other interventions coming on line all the time

Barriers to Physician Computer Order-Entry

- **Cost**
- **Provider resistance to automation**
- **Inconsistency in availability of systems across different areas of practice (e.g. amb)**
- **Lack of voice activation for medication orders**
- **Tendency for hospitals to computerize business operations over clinical**
- **Design weaknesses in computer systems**

Internet and Decision Support

- Helps by providing standard interface
- Can build standard apps with Web front end
 - Thin client helps so don't need superworkstations
- Cost reduced

Issues

- Security, confidentiality
- Standards
- Who controls data at end of day

Key Lessons

- **Physicians are happy to change direction**
 - Much less willing to stop after action started
- **Respond well to quality-related suggestions**
 - But even if low-yield utilization identified may proceed
- **Satisfaction with these efforts good**
- **Success depends on integration with practice flow**
- **Developers must think speed, speed, speed...**

Regulatory Developments

- **HCFA is developing new rules**
 - Considering mandating on-going computerized monitor
 - Initial regs set upper limit of 0 serious medication errors, are being redone
- **MEDPAC (Medicare payment advisory commission) report suggests financial incentives for POE implementation**
 - Idea is HCFA likely to mandate measurement
- **FDA's post-marketing surveillance is limited, focussed narrowly on new signals**
 - New approach would give data about rates

Medication System of the Future

- **Providers write orders on computerized systems, get feedback**
 - Face-to-face counter-detailing for complex problems
- **Orders sent directly to pharmacy**
 - Pharmacist review
- **Simple orders filled using automation**
 - Pharmacy fills complex orders manually
- **Point-of-care delivery devices linked with order-entry systems dispense medications**
 - Intravenous medications delivered by “smart” systems
- **All drugs, patients, personnel bar-coded**
 - Computerized MAR records what given, when

Conclusions

- **Providers increasingly demanding IT**
 - Immediate, individual feedback key
- **Computerizing ordering including decision support can decrease costs, improve quality, by:**
 - Providing structure, requiring fields
 - Pointing out redundancies
 - Suggesting alternatives
 - Identifying errors--both commission and omission
 - Emphasizing important abnormalities
 - Making guidelines accessible
- **Most quality measurement will be done using IT with data collection *at time care is provided***

Reducing Error in Medicine

“I don’t want to make the wrong mistake.”

Yogi Berra